REMARKS/ARGUMENTS

Claims 23-28 and 30-57 are pending in this application. By this Amendment, Applicant amends Claims 23-28, 30, 31, 34, 35, and 42, cancels Claim 29 and adds new Claims 43-57.

Claims 23-29, 31, 33, and 35 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Itakura et al. (US 2002/0158549) in view of Taniguchi (U.S. 2001/0008387) and Takayama et al. (U.S. 2004/0174233). Claim 30 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Itakura et al. in view of Taniguchi, Takayama et al., and Takamine (U.S. 2002/0135267). Claim 34 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Itakura et al. in view of Taniguchi, Takayama et al., and Nakahata (U.S. 6,025,636). Claims 32, 36-38, and 41 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Itakura et al. in view of Taniguchi, Takayama et al., and Nishiyama et al. (U.S. 2007/0132339). Claims 39 and 40 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Itakura et al. in view of Taniguchi, Takayama et al., Nishiyama et al., and Mishima et al. (U.S. 2005/0099091). Claim 42 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Itakura et al. in view of Taniguchi, Takayama et al., and Kadota et al. (U.S. 5,260,913). Claim 29 has been canceled. Applicant respectfully traverses the rejections of claims 23-28 and 30-42.

Claim 31 has been amended to recite:

> **A boundary acoustic wave device using a non-leaky propagation type boundary acoustic wave**, comprising:
> **a plurality of boundary acoustic wave elements, each boundary acoustic wave element including a single crystal substrate, a solid layer provided on the single crystal substrate, and electrodes arranged at a boundary between the single crystal substrate and the solid layer**; wherein
> the single crystal substrates have a same cut angle;
> a propagation direction of a boundary acoustic wave of at least one of the boundary acoustic wave elements is different from that of at least one of the other boundary acoustic wave elements;

a thickness of the electrodes is set so that the acoustic velocity of an SH type boundary acoustic wave is lower than the acoustic velocity of a slow transverse wave propagating through the solid layer and the acoustic velocity of a slow transverse wave propagating through the piezoelectric single crystal substrate; and

$H>8261.744\rho^{-1.376}$, when ρ (kg/m^3) represents the density of the electrodes, H (λ) represents the thickness of the electrodes, and λ represents the wavelength of a boundary wave. (emphasis added)

Claim 34 has been amended to recite:

A boundary acoustic wave device using a non-leaky propagation type boundary acoustic wave, comprising:

a plurality of boundary acoustic wave elements, each boundary acoustic wave element including a single crystal substrate, a solid layer provided on the single crystal substrate, and electrodes arranged at a boundary between the single crystal substrate and the solid layer; wherein

the single crystal substrates have a same cut angle;

a propagation direction of a boundary acoustic wave of at least one of the boundary acoustic wave elements is different from that of at least one of the other boundary acoustic wave elements;

a thickness of the electrodes is set so that the acoustic velocity of an SH type boundary acoustic wave is lower than the acoustic velocity of a slow transverse wave propagating through the solid layer and the acoustic velocity of a slow transverse wave propagating through the piezoelectric single crystal substrate; and

the piezoelectric single crystal substrate is a $LiNbO_3$ substrate, ϕ of Euler angles (ϕ, θ, ψ) of the $LiNbO_3$ substrate is in the range of -31° to 31°, and θ and ψ are in the range surrounded by points A1 to A13 shown in the following Table 1:

Table 1

Points	ψ (°)	θ (°)
A01	0	116
A02	11	118
A03	20	123
A04	25	127
A05	33	140
A06	60	140
A07	65	132
A08	54	112
A09	48	90
A10	43	87
A11	24	90
A12	0	91
A13	0	116

. (emphasis added)

Applicant's Claims 31 and 34 have been amended to be in independent form including all of the features recited in Applicant's Claim 29.

The Examiner alleged that the combination of Itakura et al., Taniguchi, and Takayama et al. teaches all of the features recited in Applicant's Claim 31, and that the combination of Itakura et al., Taniguchi, Takayama et al., and Nakahata teaches all of the features recited in Applicant's Claim 34. The Examiner acknowledged that neither Itakura et al. nor Taniguchi teaches or suggests that the thickness of the electrodes is set so that the acoustic velocity of an SH type boundary acoustic wave is lower than the acoustic velocity of a slow transverse wave propagating through the solid layer and the acoustic velocity of a slow transverse wave propagating through the piezoelectric single crystal substrate. The Examiner alleged that Takayama et al. teaches this feature. Thus, the Examiner concluded that it would have been obvious "to combine the electrode thickness of Takayama et al. with the boundary acoustic wave device of Itakura et al. as modified by Taniguchi for the benefit of reducing the propagation loss." Applicant respectfully disagrees.

Contrary to the Examiner's allegations, none of Itakura et al., Taniguchi, and Takayama et al., and Nakahata teaches or suggests any boundary acoustic wave

devices whatsoever. To the contrary, each of Itakura et al., Taniguchi, and Takayama et al. discloses **only** surface acoustic wave devices. Thus, Itakura et al., Taniguchi, and Takayama et al. clearly fail to teach or suggest the features of "a plurality of boundary acoustic wave elements, each boundary acoustic wave element including a single crystal substrate, a solid layer provided on the single crystal substrate, and electrodes arranged at a boundary between the single crystal substrate and the solid layer" as recited in Applicant's Claims 31 and 34.

In addition, the Examiner alleged that paragraphs 8 and 83 of Takayama et al. teach the feature of "a thickness of the electrodes is set so that the acoustic velocity of an SH type boundary acoustic wave is lower than the acoustic velocity of a slow transverse wave propagating through the solid layer and the acoustic velocity of a slow transverse wave propagating through the piezoelectric single crystal substrate" as recited in Applicant's Claims 31 and 34. However, paragraphs 8 and 83 of Takayama et al. disclose:

> To overcome this problem, use of a substrate with a larger cut-angle is effective for substantial reduction of propagation loss. This idea is disclosed in Japanese Patent Application Non-Examined Publication No. H09-167936. According to this publication, the cut-angle of the substrate, which minimizes the propagation loss of the LSAW propagating on the LT single-crystal and LN single-crystal, varies in response to normalized film-thickness h/λ of the IDT electrode, where h=film thickness of the electrode, and λ=wavelength of the SAW. In the case of the LT single-crystal, when the film thickness of the IDT electrode becomes 0.03-0.15 of the wavelength of the LSAW (normalized film thickness h/.lambda. is 3%-15%), a shift of the cut-angle from 36° to 39°-46° can almost eliminate the propagation loss. In the same manner, in the case of the LN single-crystal, when the film thickness of the IDT electrode becomes 0.03-0.15 of the wavelength of the LSAW (normalized film thickness h/.lambda. is 3%-15%), a shift of the cut-angle from 64° to a greater angle, such as 66°-74°, can reduce the propagation loss to almost 0 (zero).
>
> …

> A saw resonator as comparison sample 1 has the following specifications: pitch "p" of finger-electrodes 301 is 1.06 μm, and normalized film thickness h/λ is 6.0%. Another SAW resonator as comparison sample 2 has the following specifications: pitch "p" of finger-electrodes 301 is 1.0 μm, and normalized film thickness h/λ is 11%. Those samples have resonance frequencies of 1886.0 MHz (comparison sample 1) and 1884.9 MHz (comparison sample 2). The acoustic velocities of those comparison samples can be found by equation (1) and with their resonance frequencies f, comparison sample 1 has an acoustic velocity of 3998.3 m/s, and comparison sample 2 has an acoustic velocity of 3769.8 m/s. Those velocities are faster than the phase velocity of the slow shear wave propagating on the 39° Y-XLT substrate used in this first embodiment. On top of that, both of those two comparison samples do not satisfy the relation of $2xp \leq vb/f$.

Neither these portions nor any other portion of Takayama et al. teach or suggest anything at all about an acoustic velocity of an **SH type boundary acoustic wave** relative to acoustic velocities of a slow transverse wave propagating through the solid layer and the acoustic velocity of a slow transverse wave propagating through the piezoelectric single crystal substrate. In fact, as noted above, Takayama et al. is not even directed to a **boundary acoustic wave** device. Instead, Takayama et al. is specifically and exclusively directed to a **surface acoustic wave** device, **NOT a boundary acoustic wave** device, and Takayama et al. neither teaches or suggests that the structure disclosed therein could or should be used for a boundary acoustic wave device.

At best, Takayama et al. merely teaches that the acoustic velocity of a leaky surface acoustic wave should be slower than a slow shear wave propagating on the substrate. Takayama et al. fails to teach or suggest any relationship whatsoever between the acoustic wave of the surface acoustic wave and the acoustic velocity of a slow shear wave propagating through a solid layer. In fact, since Takayama et al. teaches a surface acoustic wave device, not a boundary acoustic wave device, there would not be any slow shear wave propagating through a solid layer.

Thus, contrary to the Examiner's allegations, Takayama et al. clearly fails to

teach or suggest the feature of “a thickness of the electrodes is set so that the acoustic velocity of an SH type boundary acoustic wave is lower than the acoustic velocity of a slow transverse wave propagating through the solid layer and the acoustic velocity of a slow transverse wave propagating through the piezoelectric single crystal substrate” as recited in Applicant’s Claims 31 and 34.

In the Response to Arguments section on page 13 of the outstanding Office Action, the Examiner alleged:

> Applicant’s arguments filed 24 April 2008 have been fully considered but they are not persuasive. Applicant argues that all of Itakura et al., Taniguchi, or Takayama et al. disclosed surface acoustic wave devices, not boundary acoustic wave devices. However, at least Itakura et al. discloses a boundary acoustic wave device. Applicant argues that Takayama et al. does not disclose “a thickness of the electrodes is set so that the acoustic velocity of a SH type boundary acoustic wave is lower than the acoustic velocity of a slow transverse wave propagating through the piezoelectric single crystal substrate”. While Takayama et al. does not explicitly discuss the functional language “so that the acoustic velocity of an SH type boundary acoustic wave is lower than the acoustic velocity of a slow transverse wave propagating through the piezoelectric single crystal substrate”, Takayama et al. does disclose the electrode thicknesses disclosed in the specification, and the above functional language would be inherent.

Contrary to the Examiner’s allegations, Itakura et al. does **NOT** disclose a boundary acoustic wave device. It appears that the Examiner is under the false impression that merely because the device shown in Fig. 1 of Itakura et al. includes an SiO_2 layer disposed over the IDT electrodes 5, the device shown in Fig. 1 of Itakura et al. is inherently a boundary acoustic wave device. This is clearly incorrect.

Itakura et al. clearly and specifically discloses that the device shown in Fig. 1 of Itakura et al. is a **SAW device** not a boundary acoustic wave device (see, for example, [0085] of Itakura et al.). As noted above, Itakura et al. fails to teach or suggest anything at all about boundary acoustic wave devices, and certainly fails to teach or suggest the features of “a plurality of boundary acoustic wave elements, each boundary acoustic

wave element including a single crystal substrate, a solid layer provided on the single crystal substrate, and electrodes arranged at a boundary between the single crystal substrate and the solid layer" and "a thickness of the electrodes is set so that the acoustic velocity of an SH type boundary acoustic wave is lower than the acoustic velocity of a slow transverse wave propagating through the solid layer and the acoustic velocity of a slow transverse wave propagating through the piezoelectric single crystal substrate" as recited in Applicant's Claims 31 and 34.

Thus, the Examiner's allegation that "at least Itakura et al. discloses a boundary acoustic wave device" is clearly erroneous and unsupported by any evidence of record. In fact, the Examiner's allegation is completely contrary to the clear and specific teachings of Itakura et al.

In addition, the Examiner's allegation that "[w]hile Takayama et al. does not explicitly discuss the functional language 'so that the acoustic velocity of an SH type boundary acoustic wave is lower than the acoustic velocity of a slow transverse wave propagating through the piezoelectric single crystal substrate', Takayama et al. does disclose the electrode thicknesses disclosed in the specification, and the above functional language would be inherent" is clearly incorrect. Since, as noted above, Takayama et al. teaches **only** a surface acoustic wave device, and clearly fails to teach or suggest any boundary acoustic wave devices, Takayama et al., certainly cannot possibly teach or suggest the feature of "so that the acoustic velocity of an SH type boundary acoustic wave is lower than the acoustic velocity of a slow transverse wave propagating through the piezoelectric single crystal substrate" as recited in Applicant's Claims 31 and 34, either explicitly or inherently as alleged by the Examiner.

With respect to the feature of "$H>8261.744\rho^{-1.376}$, when ρ (kg/m^3) represents the density of the electrodes, H (λ) represents the thickness of the electrodes, and λ represents the wavelength of a boundary wave" recited in Applicant's Claim 31, the Examiner alleged that Taniguchi teaches this feature because, "[t]he claim language does not define the wavelength or how to determine it; therefore, the wavelength can be

any desired value. Therefore, the electrode thickness would meet the condition $H>8261.744\rho^{-1.376}$." Applicant respectfully disagrees.

One of ordinary skill in the art would clearly understand that the wavelength of a given acoustic wave device is determined based on the characteristics of the IDT electrodes, i.e. electrode finger thickness, electrode finger width, electrode finger pitch, etc., and that, in a given acoustic wave device, the wavelength has a specific value and certainly cannot be any desired value, as alleged by the Examiner. Since Taniguchi fails to teach or suggest any specific thickness of the IDT electrodes, contrary to the Examiner's allegation, Taniguchi certainly fails to teach or suggest the feature of "$H>8261.744\rho^{-1.376}$, when ρ (kg/m^3) represents the density of the electrodes, H (λ) represents the thickness of the electrodes, and λ represents the wavelength of a boundary wave" as recited in Applicant's Claim 31.

With respect to Claim 34, the Examiner alleged that "it would have been obvious to a person of ordinary skill in the art to combine the crystal orientation of Nakahata with the boundary acoustic wave device of Itakura et al. as modified by Taniguchi and Takayama et al. for the benefit of an acoustic velocity of 8000 m/s or higher." However, the Examiner has failed to explain (1) why one of ordinary skill in the art would want the acoustic velocity of the surface acoustic wave device of Itakura et al. to be 8000 m/s or higher; and (2) what specific benefit would have been obtained if the acoustic velocity of the surface acoustic wave device of Itakura et al. was 8000 m/s or higher.

In addition, contrary to the Examiner's allegation, the acoustic velocity of 8000 m/s or higher in Nakahata is clearly **NOT** achieved due to the Euler angles θ and ψ. Instead, col. 10, lines 34-42 of Nakahata specifically disclose, "the propagation velocity V is **exclusively** determined by kh_1 of the $LiNbO_3$ layer 310… It is confirmed from FIG. **5** that , when kh_1 is equal to or smaller than 0.7, a propagation velocity V equal to or higher than 8000 m/s is ensured." Thus, as clearly disclosed in Nakahata, the Euler angles θ and ψ have absolutely no effect on the acoustic velocity of the surface acoustic

wave device.

Therefore, contrary to the Examiner's allegations, there would have been absolutely no reason or motivation for one of ordinary skill in the art to modify the surface acoustic wave device of Itakura et al. so as to include the feature of "the piezoelectric single crystal substrate is a $LiNbO_3$ substrate, ϕ of Euler angles (ϕ, θ, ψ) of the $LiNbO_3$ substrate is in the range of -31° to 31°, and θ and ψ are in the range surrounded by points A1 to A13 shown in the following Table 1" as recited in Applicant's Claim 34.

Accordingly, Applicant respectfully requests reconsideration and withdrawal of the rejection of Claim 31 under 35 U.S.C. § 103(a) as being unpatentable over Itakura et al. in view of Taniguchi and Takayama et al., and the rejection of Claim 34 under 35 U.S.C. § 103(a) as being unpatentable over Itakura et al. in view of Taniguchi and Takayama et al., and further in view of Nakahata.

The Examiner relied upon Takamine, Nishiyama et al., Mishima et al., and Kadota et al. to allegedly cure various deficiencies of Itakura et al., Taniguchi, and Takayama et al. However, Takamine, Nishiyama et al., Mishima et al. and Kadota et al. fail to teach or suggest the features of "a thickness of the electrodes is set so that the acoustic velocity of an SH type boundary acoustic wave is lower than the acoustic velocity of a slow transverse wave propagating through the solid layer and the acoustic velocity of a slow transverse wave propagating through the piezoelectric single crystal substrate," "$H>8261.744\rho^{-1.376}$, when ρ (kg/m^3) represents the density of the electrodes, H (λ) represents the thickness of the electrodes, and λ represents the wavelength of a boundary wave", and "the piezoelectric single crystal substrate is a $LiNbO_3$ substrate, ϕ of Euler angles (ϕ, θ, ψ) of the $LiNbO_3$ substrate is in the range of -31° to 31°, and θ and ψ are in the range surrounded by points A1 to A13 shown in the following Table 1" as recited in Applicant's Claims 31 and 34. Thus, Applicant respectfully submits that Takamine, Nishiyama et al., Mishima et al. and Kadota et al. fail to cure the deficiencies

of Itakura et al., Taniguchi, and Takayama et al. described above.

Accordingly, Applicant respectfully submits that Itakura et al., Taniguchi, Takayama et al., Takamine, Nakahata et al., Nishiyama et al., Mishima et al. and Kadota et al., applied alone or in combination, fail to teach or suggest the unique combination and arrangement of features recited in Applicant's Claims 31 and 34.

In view of the foregoing amendments and remarks, Applicant respectfully submits that Claims 31 and 34 are allowable. Claims 23-28, 30, 32, 33, and 36-57 depend upon Claims 31 and 34, and are therefore allowable for at least the reasons that Claims 31 and 34 are allowable.

In view of the foregoing amendments and remarks, Applicant respectfully submits that this application is in condition for allowance. Favorable consideration and prompt allowance are solicited.

The Commissioner is authorized to charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account No. 50-1353.

Respectfully submitted,

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